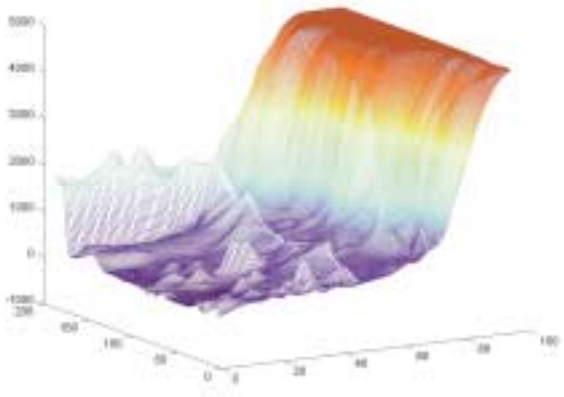
Development of a Parallel Adaptive Ocean Circulation Model with PARAMESH

PI: John Lou/JPL

Objective

- Apply and extend the PARAMESH library's capability to enable parallel adaptive ocean circulation modeling. (PARAMESH was developed by GSFC for Magneto-hydrodynamic modeling problems)
- Create an adaptive multi-level Regional Ocean Model System (ROMS) in a U.S. west coastal region with three grid resolutions (50, 5 & 1 km) under the general adaptive computing framework of PARAMESH.



U.S. west coastal ocean topography on a three-level adaptive grid

Approach

- Integrate PARAMESH and ROMS into a single executable in Fortran 90 and MPI.
- Customized and extended PARAMESH as needed for parallel adaptive ocean modeling.
- A demo problem will be first implemented and tested, followed by code optimizations, and a test on a realistic problem.

Key Milestones

- Demonstrate the integrated PARAMESH-ROMS model on an idealized test problem with three grid resolutions. (09/03)
- Achieve parallel load-balancing on the PARAMESH-ROMS model. (03/04)
- Communication optimizations; apply the model to a realistic problem off the California coast at the highest resolution of 1 km or better. (09/04)

CoIs: Y.Chao/JPL
Partners: K.Olsen, P.McNiece/GSFC

TRL_{in} =4

ESTO Earth Science Technology Office

Development of a Parallel Adaptive Regional Ocean Model with PARAMESH

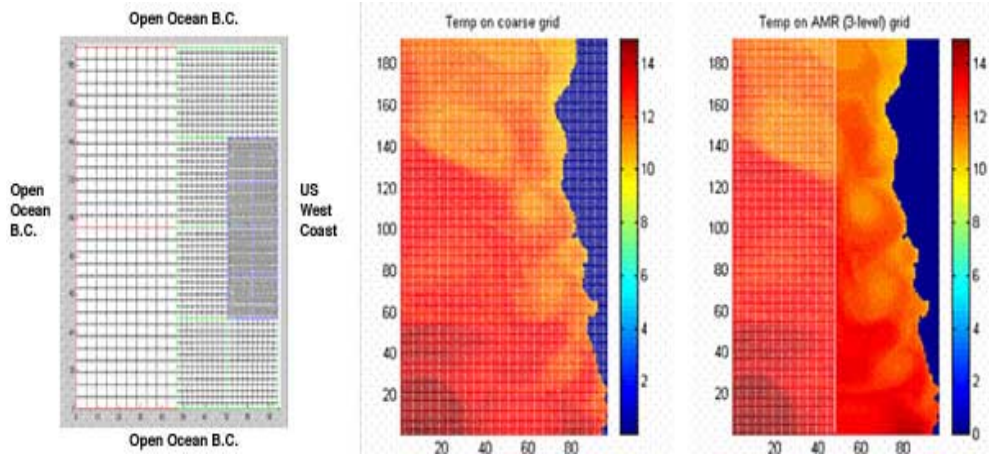
PI: Dr. John Z. Lou, Jet Propulsion Laboratory

Objective

• Enable modeling physical oceanography with variable grid resolution and make it possible to achieve very high numerical accuracy for ocean simulation near coastal regions.

• Apply the PARAMESH library and develop additional algorithms and code to create a computational model for multi-level, adaptive ocean modeling on large-scale multiprocessor computers.

An adaptive grid (left) and computed temperature fields on the coarse grid (middle) and on adaptive grid (right)



Accomplishments

- Integrated the PARAMESH library and UCLA/JPL's ROMS program into a single executable, Fortran 90 and MPI based program. Reported PARAMESH bugs and issues to its developers.
- Developed a unique framework for multi-level adaptive modeling of regional oceans, based on the ROMS algorithms, on large-scale multiprocessor computers. It is the most flexible adaptive ocean modeling framework known today.
- Developed a set of software routines supporting the specific needs of parallel adaptive ocean modeling.
- Tested the developed adaptive ROMS program in a reasonably realistic setting - the U.S. west coastal region.

CoIs: Dr. Yi Chao, Dr. Gene Li, and Carrie Chang, JPL

TRL_{in}=4; TRL_{out}=5

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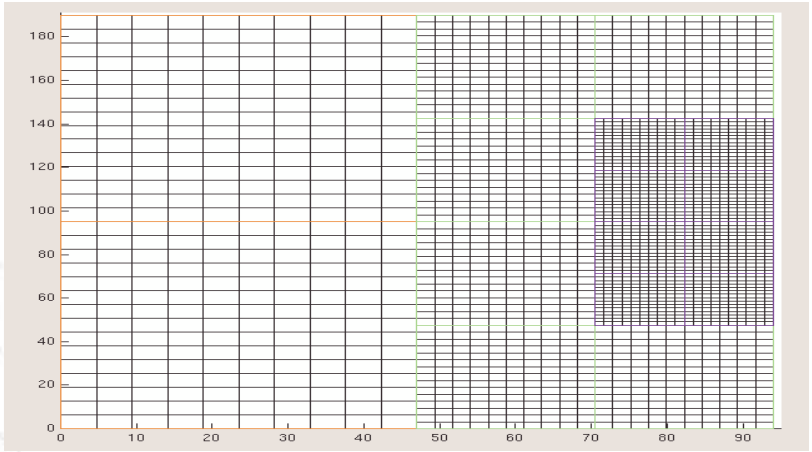
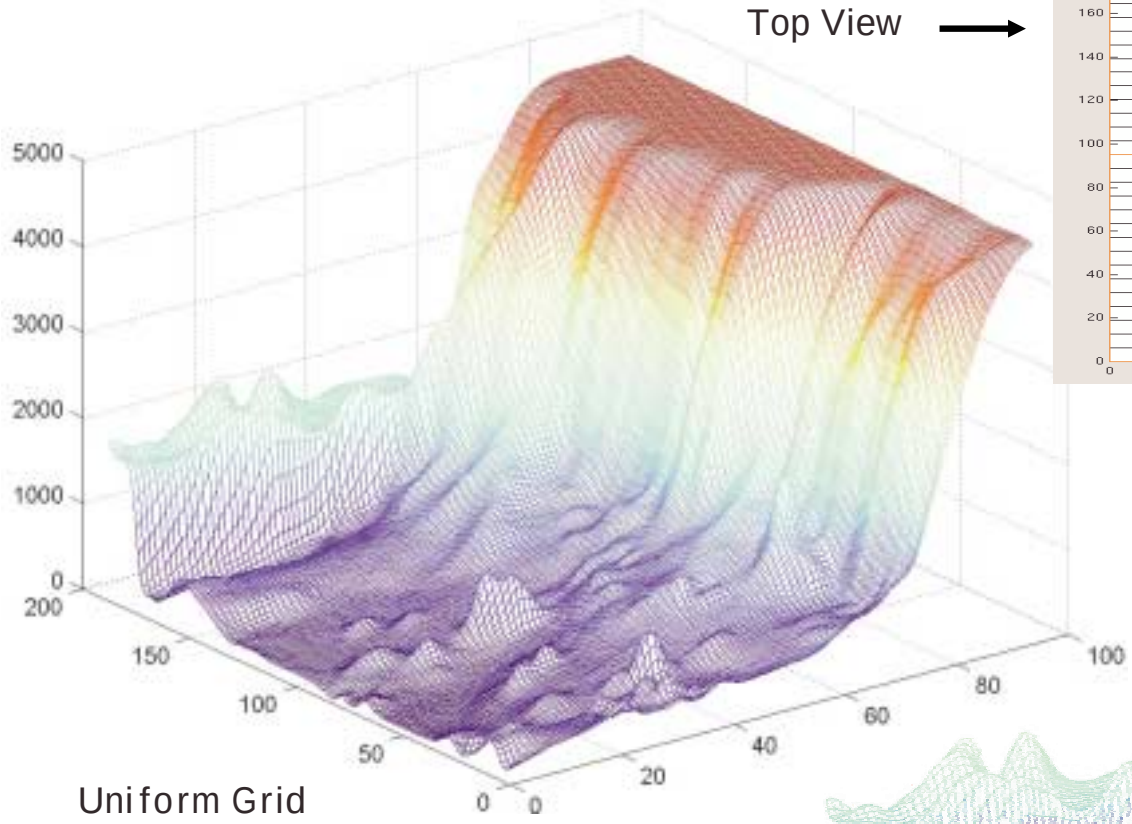
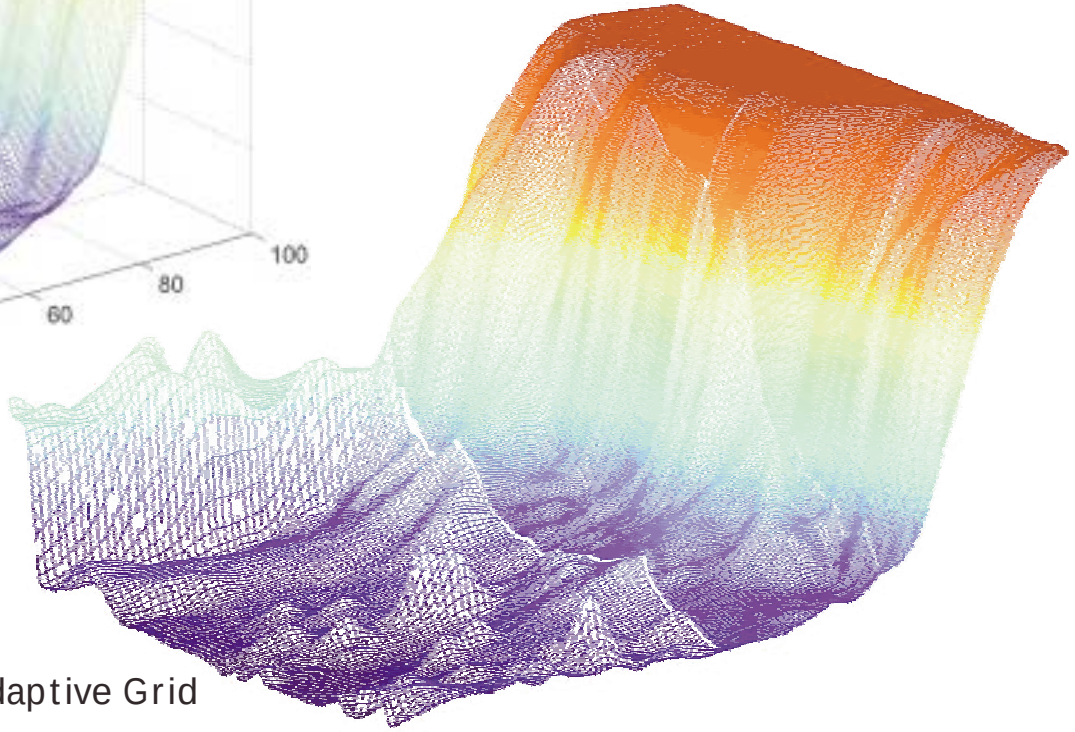
A Three-Level AMR Ocean Topography Grid

3 Level Adaptive Grid
Top View





Uniform Grid

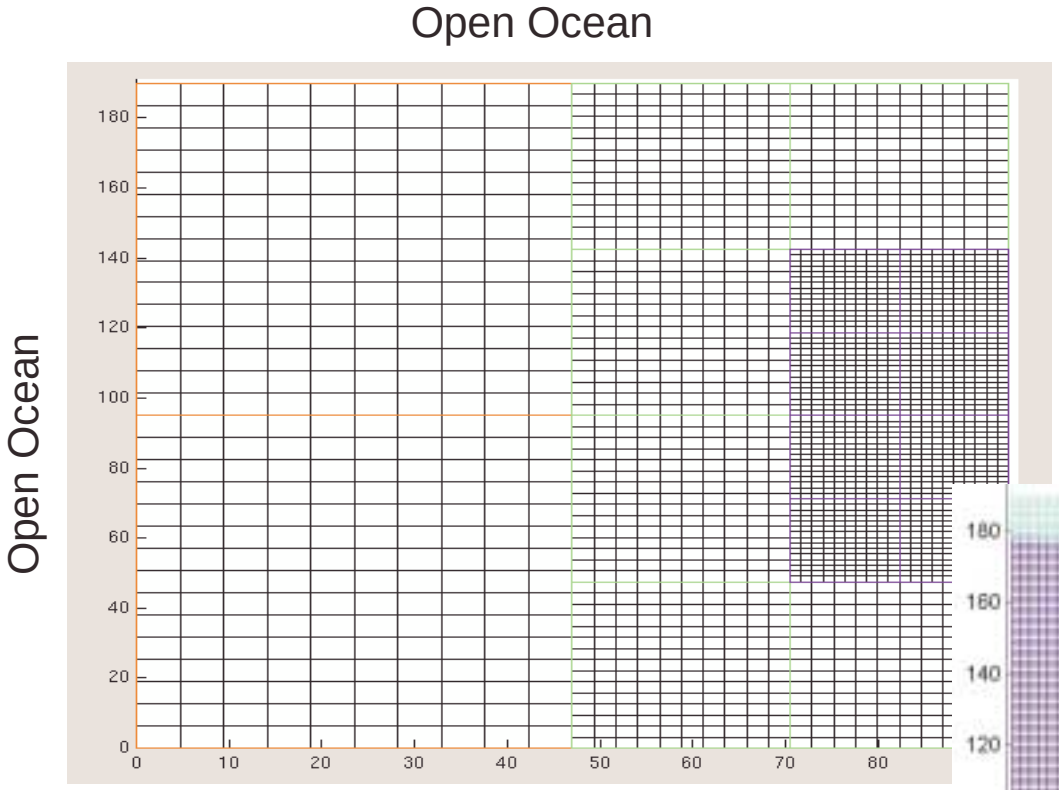


3D Perspective Views

3 Level Adaptive Grid

Reported 2/24/05 Monthly

Application to Coastal Ocean Simulations



Adaptive refinement on longitude-latitude planes of a 3D ocean grid

Grid points can be concentrated at the coast where topography changes rapidly, while smoothly transitioning to lower density in the open ocean

Ocean Surface Temperature on the Adaptive Grid